LEARNING OBJECTIVES

- Contrast the difference between prevailing theories of motor control and motor learning

- Explain the role and importance of attention and memory in relation to coaching and skill learning

- Discuss considerations for optimizing the practice and training environment to improve skill learning

- Discuss considerations for improving instruction and feedback to improve skill learning
Will the results be the same?

No different athletes
Same program

01

MOTOR CONTROL THEORIES
MOTOR CONTROL THEORIES

+ Explain Coordination in terms of movement performance and skill acquisition

+ Provide an explanation for Bernstein’s “Degrees of Freedom Problem.”

...Why?

MOTOR CONTROL THEORIES

+ Coordination
  - Patterning of head, body, and limb movements relative to the patterning of environmental objects and events (Turvey, 1990)

+ Degrees of Freedom Problem
  - Design problem involves determining how to constrain the system’s many degrees of freedom so a specific result is produced (Magill, 2011 & Bernstein, 1967)
**MOTOR CONTROL: THEORY ONE**

- **Central Control or Motor Program Theory**
  - “a memory-based construct that controls coordinated movement” (Magill, 2011)

- **Generalized Motor Program (GMP)**
  - Memory based representation of a class of actions with common invariant features
  - Provides the basis for controlling a specific action within a class of actions

- **Schema Theory (Schmidt, 1975)**
  - A set of rules that provide the basis for a motor skill

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**MODEL FOR MOTOR PERFORMANCE: CLOSED LOOP**

Adapted From Schmidt and Wrisberg, 2008-
Motor Learning and Performance- A Situation-Based Learning Approach
MOTOR CONTROL: THEORY TWO

+ Dynamic Systems Theory
  - Approach to describing the control of coordinated movement that emphasizes the role of environmental information and the dynamic properties of the human body (Magill, 2011)
  - Nonlinear Behavior (Kelso, 1984)

+ Attractor State (Motor Program Equivalent)
  - A preferred behavioral state that is said to be stable or homeostatic
  - Occurs and can change in response to constraints within the human body, environment, and/or task

+ Self-Organization
  - Spontaneous expression of a motor skill in response to specific tasks, environment conditions, and biological capabilities (Attractor State)
Learn through “play”

“Hands-off” coaching model

“Constraints” drive movement solutions

SELF-ORGANIZATION (CONSTRAINT-BASED) MODEL

“The optimal pattern of coordination is determined by the interaction among constraints specified by the person, the environment, and the task” (Newell, 1986)

Adapted From: Davids, K., Button, C., and Bennett, S., 2008
Relative-time for gait was found to be different for walking and running, indicating they are controlled by different GMP or attractor states. Shapiro et al., 1981
MOTOR LEARNING MODELS

- Fitts and Posner 3-Stage Model (1967)
  - Cognitive Stage
  - Associative Stage
  - Autonomous Stage

- Gentile 2-Stage Model (1987, 2000)
  - Initial Stage Learning
  - Later Stage Learning

- Newell 3-Stage Model (1985)
  - Coordination Pattern
  - Coordinative Structure
  - Optimization of Control

- Anderson and Lebiere (1998)
  - Declarative Phase
  - Procedural Phase

FITTS AND POSNER 3-STAGE MODEL

- Identify Objectives
- Self-talk/Questioning
- ↑ Errors/Variability
- Instruction/Feedback
- Associate with Cues
- Refining/Consistent
- ↓ Errors/Variability
- Identify/Correct Errors
- Subconscious/Auto
- Multiple Tasks
- ↓↓↓ Errors/Variability
- ↓↓ Identify/Correct Error

PRACTICE TIMELINE

ATTENTION

+ Characteristics associated with consciousness, awareness, and cognitive effort

+ Relating to limitations associated with the performance of multiple skills and the detection of relevant information in the environment
ATTENTION AS A LIMITED RESOURCE

Movement Task

NOVICE

Attention Capacity

EXPERT

Focus on Cueing

(Adapted From: Magill, R., 2011)

MEMORY

- Short-Term Sensory Store:
  - Peripheral memory system, which holds incoming information until identified (lost after .5s)

- Short-Term Memory:
  - Allows retrieval, practice, processing, and transfer of information...Limited Capacity (7 ± 2 items & lost after 10s)

- Long-Term Memory:
  - Memory system that holds information and life experiences...Unlimited Capacity (contains GMP)
Write down 3-5 sentences contrasting the central control and dynamic system theories of motor control.

Write down the 3-stages of motor learning and 1-2 characteristics of each stage (Fitts & Posner).

Write down 3-5 sentences discussing the role of attention and memory in coaching and learning.
OPTIMIZING THE LEARNING ENVIRONMENT

PRACTICE DESIGN

✦ Goal
  - Optimize learning and retention in an effort to reach maximum transfer to the sporting environment

✦ Key Terms
  - Practice Variability
  - Contextual Interference
Practice Variability:
- The variety of movement and context characteristics a person experiences while practicing a skill

Contextual Interference (CI):
- The memory and performance disruption that results from performing multiple skills or variations within the context of practice

Contextual Interference Effect (Battig, 1979):
- Learning benefit from performing multiple skills in a high CI practice schedule (i.e. Random), rather than skills in a low CI practice schedule (i.e. Blocked)

PRACTICE DESIGN

- Blocked Practice
  - 50 Shots each
- Serial Practice
  - Random Practice
  - 5 Shots each x 10
  - 1 Shot each x 150

EXOS

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PRACTICE DESIGN

- **Cl and Practice:**
  - High Cl conditions may have a negative affect on current performance within a practice setting compare to low Cl conditions

- **Cl and Retention/Learning:**
  - High Cl conditions can results in significantly higher retention and learning following a series of practice sessions

CONTEXTUAL INTERFERENCE APPLIED

Day 1: Acceleration  
Day 2: Deceleration  
Day 3: Drop Step  

Day 1:  
1. Acceleration  
2. Deceleration  
3. Drop Step  

Day 1:  
1. Accl-Decl  
2. Decl-Drop St  
3. Accl-Decl-Drop St
Moderately Skilled Learners Benefit by Practicing with Systematic Increases in Contextual Interference

**Design:**
- N=45 practiced 3 different basketball passing strategies under a blocked, random or progressive practice schedule.

**Results:**
- A progressive increase in CI from a blocked to random schedule improved retention of passing skills better than a random or blocked only schedule.

Porter et al., 2010
BIG TICKET ITEM...

- Increased CI is associated with a short-term performance decrement in practice that results in significant improvements in learning and retention...

PRIMING THE MOTOR SYSTEM: INSTRUCTION
VERBAL INSTRUCTION

- Provide 1-2 focus cues to build awareness
- Limit unnecessary information ("Over-Coaching")
- Start and finish instruction with what you want versus what you don’t want
- Focus attention externally on the outcomes opposed to internally on the body process
VERBAL INSTRUCTION: CUEING

- Internal Cueing: Focused on “Body Movement”
  - Joint reference: “Squeeze your shoulder blades”
  - Muscle reference: “Squeeze your glutes”

- External Cueing: Focused on “Movement Outcome”
  - Environment reference: “Explode off the ground”
  - Outcome reference: “Jump as high as you can”

INTERNAL VS. EXTERNAL CUEING

APPLIED TO HOPPING

- Internal
  - “Explode through your hips”

- External:
  - “Explode off the ground”
External Focus Improves Performance during Practice and Retention of a Ski Simulator/Balance Task

† Design:
   - N=33 performed a ski-simulator task under internal (“outside edge of feet”), external (“outside wheels”), or a non-focus condition

† Results:
   - External condition out-performed internal as measured by platform amplitude and frequency during practice and retention

Wulf et al., 1998

VISUAL INSTRUCTION: OBSERVATION

† Watching a expert performer
   - Mirror Neurons

† Watching a novice performer
   - Improves problem solving and discovery

† Combining both creates context to know what the novice is doing wrong and drives learning
BIG TICKET ITEM...

Combining visual and verbal instruction may be more beneficial than either independently... Visual creates an image and verbal (external focus) can drive the outcome of what the image represents...

REFINING THE MOTOR SYSTEM: FEEDBACK
Knowledge of Results: Information about the outcome of a skill or if a goal was achieved
- Quantitative

Knowledge of Performance: Information about movement characteristics that led to the outcome
- Qualitative

Example...Running a 40yd Sprint
- KR: "You ran the 40yds in 4.56s"
- KP: "Focus on pushing off the ground during the start"
**FEEDBACK: TASK-INTRINSIC**

- The higher the task-intrinsic feedback the less need for augmented feedback
- The lower the task-intrinsic feedback the greater need for augmented feedback

**FEEDBACK: HOW MUCH?**

- Guidance Hypothesis (Salmoni et al., 1984)
  - Feedback guides the athlete/client towards the correct movement skill, but when given too frequently can have detrimental affects on the movement skill and create feedback dependence...
The Frequency of Feedback has a Direct Effect on Performance Outcomes in Practice and Retention

+ Design:
  - Design: N=52 participants took part in a passing accuracy task. Feedback frequency and internal vs. external focus was examined. (100% Int, 100% Ext, 33% Int, 33% Ext)

+ Results:
  - An external focus was superior to an internal focus
  - 33% feedback was superior to 100% feedback for INT Focus
  - 33%/100% feedback were equally effective in EXT Focus

Wulf et al., 2002

FEEDBACK: DANGERS OF TOO MUCH

+ Coach dependence “DVD Player Analogy”

+ Less dependence on intrinsic process

+ False view of improvement...
  - Practice well, but when feedback is removed retention/learning is not expressed on the field

+ “Paralysis by Analysis”
FEEDBACK: TIMING

- **Bandwidth**
  - Feedback given when error reaches a limit of is outside the correct bandwidth

- **Summary/Average**
  - Feedback is given after a number of trials have been observed and the average errors have been identified

- **Fading**
  - Feedback is given more frequently at the beginning of a session and is progressively decreased

- **Self-Selected**
  - Feedback is given to the athlete at their request
  - Very Good...Not Sure...Very Bad

FEEDBACK: CONTENT

- **Movement Analysis**
  - Major Technical Components
  - Direct Feedback at Weakest Link
    - Cause vs. Symptom (Prioritize)

- **Guide rather than prescribe**
  - Ask a question before you give an answer

- **Coach the “how” not the “what”**
CHECK FOR LEARNING

- Write down 2-3 ways you can integrate contextual interference into movement on the field and strength in the weight room
- Write down 2-3 key strategies for optimizing instruction
- Write down 2-3 key strategies for optimizing feedback

CLOSING
ENVIRONMENT

- Optimizing practice and training conditions to improve learning and transfer to sport and life

INSTRUCTION

- Prime the motor system through externally focused verbal instruction and observational learning with novice and expert models
Refine the motor system through appropriately timed feedback that guides rather than prescribes
APPENDIX


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